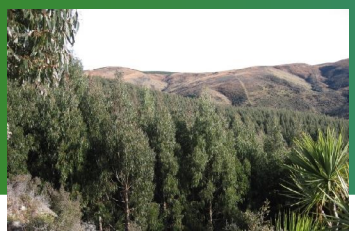

DIVERSIFIED SPECIES THEME UPDATE

Number: 08

Theme Leader: Patrick Milne

Date: August 2012

Meeting held in Rotorua, 14th August 2012

Introduction

As Russell Dale said, we are now entering the fifth and final year of the Diversified Species programme. By the middle of next year we should know how much government funding will be obtained from the Contestable Funding pool. This pool, amounting to a paltry $40 million, must subsidise research into a variety of land uses including dairying, meat and wool and wine. Industry contributions are essential but government help is also critical in assuring the continuation of important work. It would be a tragedy if this fledgling Theme, which has achieved so much in its short history, were to be throttled in its infancy by post-quake stinginess.

On the bright side, there seems to be a trend towards more public and government interest in alternative species. This may have been boosted by the kiwifruit experience and by the Red Needlecast scare of radiata pine, but it also may be a reflection of the desire to fill markets that radiata cannot. For example, radiata has never been ideal for engineering-grades, and many of our existing forestry locations cannot produce such material even with Douglas-fir. Remote locations may not be commercially viable for forestry unless they are used for very high value species.

Patrick Milne, despite serious health problems, has steered the Diversified Forests programme with vigour and enthusiasm. He summed up the need for the Theme (risk reduction, increased market opportunities, general Licence to Operate), and highlighted the main species and the barriers to their widespread adoption. Greg Steward – who has now taken over from Heidi Dungey as Programme Leader – then summarised the impressive achievements of this small but powerful Theme, with a list of what it hopes to do in the coming year.

This article was written by:
Piers Maclaren, Piers Maclaren & Associates Ltd for FFR Diverse Species Theme Members

How does stiffness in Douglas-fir vary with site?

Last year's work by Stuart Kennedy showed that Douglas-fir (like radiata pine) produces wood of lower quality (in particular stiffness and/or sonic velocity) on cooler or higher altitude sites. Density and velocity are highly correlated, and vary widely around the country. The causes are not understood in detail, but the critical factors are clearly mean annual temperature, tree age and soil fertility. From these factors it is possible to estimate and wood quality throughout New Zealand. Updated maps based on this were provided. The important point to note is that the locations where much of our Douglas-fir is currently grown does not meet – on average – the specifications for engineering grade lumber (basic density of over 400 kg m^{-3} and branch index of less than 40 mm). This species was planted in these colder, higher altitude sites because they tolerated such conditions better than radiata pine, but in view of Stuart's work we must question the wisdom of this choice.

The deficiencies of the prime Douglas-fir locations can be mitigated with silviculture (higher stockings) and careful choice of genetics, but these are unlikely to be sufficient in the short term to fully compensate. One point to mention is that Stuart's maps involve *average* figures of density and velocity, but there will be acceptable trees within most stands and acceptable lumber within most trees. So, even if the news is not good for some sites, all is not lost.

The Douglas-fir Breeding Programme

It is apparent that considerable progress can be made by geneticists in overcoming Swiss Needlecast and in improving wood quality. Heidi summarised the progress to date. In the two decades since the start of the Douglas-fir Coop (the Theme's predecessor), working to an agreed breeding plan we have achieved 20-30% improvement in growth and form, as well a new selections for stiffness and health.

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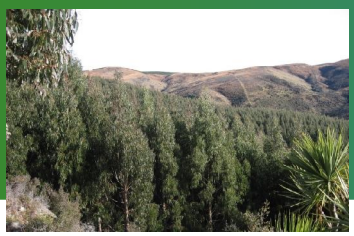

DIVERSIFIED SPECIES THEME UPDATE

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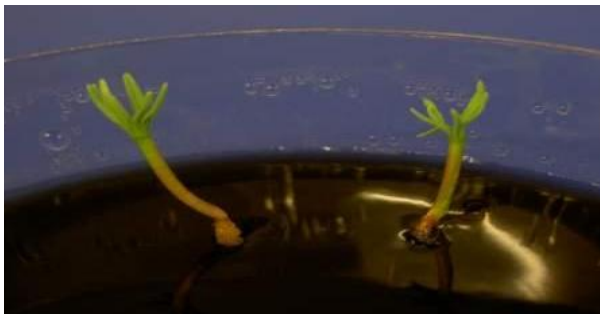
One significant discovery was that, although the provenance rankings generally remained the same for sonic velocity across all sites, there were minor alterations in the rankings for straightness and only moderate changes for diameter. In other words, it is important to choose a good site, but having done that, you can be confident that the best genetic stock nationally is also likely to be the best for your own site.

Siting of Douglas-fir plantations impacts on lumber stiffness

Predicted genetic gains are in the region of 10-15%, or a calculated increase in NPV of $865/ha. The heritability of SNC is 0.37 and for stiffness it is an astonishing 0.5, indicating that there is huge potential for genetic improvement. Climate change is likely to increase the prevalence of SNC (already a universal problem), and given that a rotation of Douglas-fir may be half a century long, we need to be planting disease-resistant trees right now.

Cathy Hargraves' work (multiplication by means of embryogenesis) is of international significance, and may lead to the possibility genetic engineering. Although politically unpopular, it would mean that sterile trees could be deployed with no possibility of wilding tree spread.



Success with embryogenesis

Eucalyptus Species

Procedures to improve the genetics of the two leading ash eucalypts (*regnans* and *fastigata*) include the assessment of growth of trees planted in Compartment 333 Kaingaroa. The families prone to forking will be identified – this is supposedly a problem with *fastigata*. As the incidence of forking was seen to be low, the species may have been unjustly slandered, or else this undesirable tendency may have been overcome in the first stages of the breeding programme.

On average the *regnans* is 6.2 m tall (the best family 6.8 m and the worst 4.9 m – still impressive). Exceptional trees are nine metres tall at age 2.5 years! No diseases are apparent. *Fastigata* is not as vigorous (average is 4.6 m, best family 5.4 m, worst 3.8 m). Predictions from the Calculator are for a massive 800-950 m^3 at age 20. For many reasons, these eucalypts cannot and must not be overlooked.

2½ year-old E. regnans – Kaingaroa

Work also continues on *E. nitens*. If it were not for the *Paropsis* beetle, *E. nitens* is capable of even higher volumes than the two previously mentioned, and is an obvious candidate for a pulp or bioenergy crop. Shaf van Ballekom would like to see its potential for solid wood explored, if only for use in LVL, but Heidi commented that it has the lowest wood quality of the

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various candidate species. As there will be little interest in *nitens* until the insect problem is truly overcome, Shaf would also like to see the breeding programme focussed exclusively on *Paropsis* resistance. Toni Withers, at Scion, is attempting a new biocontrol agent: *Eadya paropsidis*.

Commenting on Eucalypts in general, Ian Nicholas said that the market for solid lumber was already present: "it is just a matter of connecting the dots". Dean Satchell's work supports Ian's statement.

Cypresses

Work on breeding and cloning cypresses continues apace, and it is not impossible that they could soon become the third leg of New Zealand's forestry stool. For the second-generation *lusitanica* progeny trial, the heritability of dbh, straightness and branch size was 3.7 – most encouraging. Although only 5 years old, the average diameter was 12 cm with the best trees over 20 cm – almost equal to radiata pine.

Meanwhile, the synthetic hybrids (Leylands and others) are growing well, and will possibly be available to the general public in about 4 years. They will be better than currently available *ovensii* although not tested for wood quality. A new hybrid trial is to be established using promising combinations of *C. lusitanica*, *macrocarpa*, *arizonica* and *guadalupensis* cypress, and *Ch. nootkatensis* – some of which combinations have never previously existed.

Canker-resistant *macrocarpa* has been selected for a breeding orchard. This is hugely significant, because this species in its pure form is extremely productive and ticks all the boxes except one. The only weak link in the chain from seed to end product is cypress canker. It is an obvious target for research, and is another good reason why Government should not drop the ball at this critical time.

Redwoods

There has been a lot of recent interest in redwood, because of its phenomenal growth in New Zealand, the enthusiasm of the market in California, and the ability of redwood to meet environmental goals (erosion, carbon mitigation and recreation). Dean Meason discussed all these things.

The first priority was to establish a robust genetic base, as the early plantings were randomly chosen and largely inbred. In 2011, three benchmarking trials were established to rank the material already present in this country. This would eventually be compared with 100 plus-tree selections from various American selections. The breeding programme would then lead on to progeny trials and so on.

In order to generate interest in the species, it is necessary to make a profitability estimate – which involves the use of a growth model. The dataset was very poor, to say the least. Therefore an early step was to increase the number and distribution of PSPs, to improve the redwood model, and to develop site productivity surfaces (redwood has a "productivity 400 Index" similar to the familiar 300 Index for radiata pine). From this work it will be possible to identify the site factors which drive productivity. An analysis of volume and taper equations will enable volume by log grades to be estimated.

Another angle is to investigate management practices. The correct mycorrhizae are very important for establishment of this species. Thinning is quite different to radiata in that there appears to be no thinning response – at least not in the seven years so far observed. This may be because redwood is a very shade tolerant species, or it might be something to do with the prolific root-grafting, or the fact that the "control" only had 1667 trees – a high stocking by redwood standards. Pruning responded in a similar way to radiata in that it reduced diameter growth, but after a year or two pruned trees rapidly recovered.

Redwood silvicultural trial at Tutira

A sawing study of a 38-year old Mangatu stand enabled a breakdown of lumber into 9 grades, with

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pruned logs yielding 64% of the five most valuable grades in contrast to only 28% in the unpruned logs. There was also a huge difference between high quality and low quality pruning, given that poor pruning can result in epicormic shoots and largely negating the process. The superior quality is not solely due to the absence of knots, it also involves such things as heartwood (giving colour and durability). The Mangatu study showed that trees only 38 years old produced a large proportion of heartwood (44-66%). Wood density was highly variable between trees, signalling a possible breeding opportunity.

The potential of redwoods for erosion control is generating considerable interest. It is a long-lived species with a dense canopy, and with wide-spreading lateral roots. It coppices and root grafts. So it should be an excellent choice, except for the fact the benefits cannot yet be proved. This is an important area for research over the next 5-10 years.

Carbon has gone out of favour with recent rock-bottom prices, but redwood has been identified as having great potential in this regard: it is long lived and can support huge amounts of biomass. If carbon comes back into vogue it will be crucial to create reliable volume and density equations for redwood, and investigate how biomass is allocated around a tree, including into the roots.

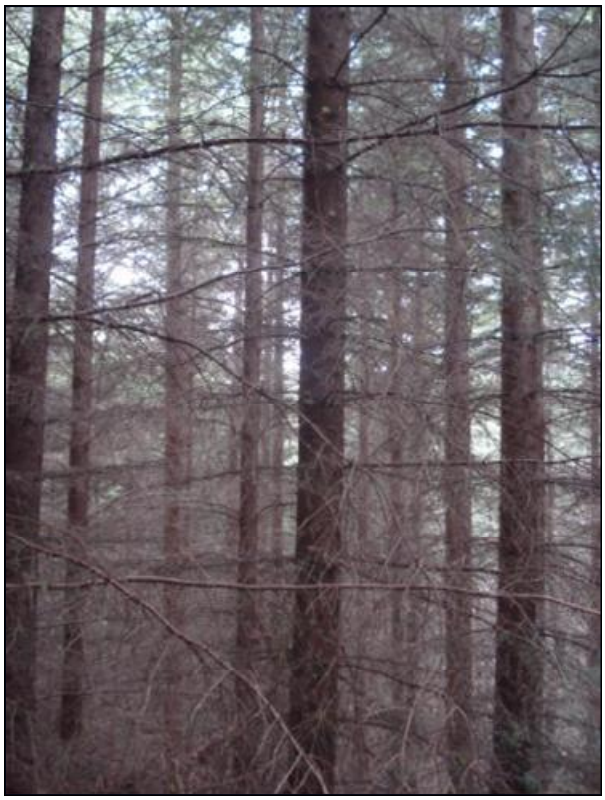
The market analysis is somewhat vague. Redwood sells for phenomenal prices in California, but NZ-grown wood is seen as inferior. Perhaps this is merely because it is unfairly compared to material from old growth native forests? Or perhaps the perception is mainly within New Zealand and does not extend to the consuming country? In any case, it is important to distinguish the perception from the reality, and to establish a solid foundation for a timber industry as well as for carbon forestry, erosion forestry and recreational uses.

Complex Problem Solving

With regard to multiple objectives, such as maximising economics, social and environmental benefits, it is often difficult to find an optimum solution that meets all goals. Not only is it difficult to do politically, but it is difficult mathematically. Oliver Chikumbo has come up with a way to make such difficult calculations. It involves genetic algorithms and multiple iterations. Unfortunately, most people seem to struggle with the assumptions or the mathematics, and this author's opinion is that decision-makers will probably ignore Olly's good work. Nevertheless, the history of science shows that on occasions there can be massive spin-offs from the most unlikely projects, so one never knows.

Weird and Wonderful Species

Due to its smaller budget, the Diversified Forests There will always be people who question the species chosen for intensive research. Why not other types of tree? Fortunately, the programme has Charlie Low – a recent FFR award winner, who has a lifetime's wealth of knowledge about many, many species. He discussed the spruces: Norway and Sitka; the firs: *Abies religiosa*, *concolor*, *magnifica* and *grandis*; the pines: *muricata*, *ayacahuite*, *patula*, *greggii* and *montezumae*; and the eucalypts: *fastigata* and *saligna*. For each of these, Charlie had some comment to make. For example, *E. dendromorpha* is the best eucalypt for cold and exposed sites, *P. ayacahuite* has wood like cypress and is durable, *A. concolor* is suitable for high-country forestry. This illustrates the need to at least maintain our genetic resources, not to mention the institutional knowledge that Charlie exemplifies.



Norway spruce at Blackmount, Southland

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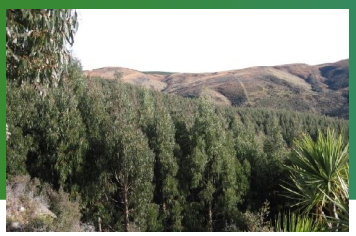

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Totara

There is continuing demand for indigenous trees for things like riparian planting, but it is not obvious what will work in each situation. Dave Bergin is investigating totara planting among the willow-infested swamps near Lake Rotoiti. But even if a species grows well, natives are usually too expensive to justify, so Dave is examining the possibility of bare-rooted stock.

We have four species of totara and they hybridise, so how do we distinguish them? How do we use the virtues of each to best advantage? The first step is to develop DNA markers. They will be identified and tested on samples from a wide range of geographic locations. It will be particularly interesting to see how totara is affected by altitude gradients.

This is an amazing high-tech piece of research that ropes in some of the top talent from CRIs, universities and others. It has enthusiastic support from Maori leaders. Moreover, the skills and insights derived from this project are bound to have huge spin-offs in other areas. Molecular technologies such as these can be used in every tree species we grow, or are thinking of growing. There could also be spin-offs that impact outside the forestry sector.

There's renewed interest in totara

Kauri

An interesting study assessed wood density in planted kauri and found that it was remarkably constant: it did not vary between planted and natural forest; it was almost independent of tree age it was not affected by dbh or dbh increment; and lastly it seemed to be independent of latitude. The average of the 14-68 year-old trees was 452 kg/m^3 whereas old-growth heartwood is not much more, at 500 kg/m^3. If you want to know how much heartwood there is, here is a simple rule of thumb: measure the dbh, deduct 30 cm and the remainder is heartwood!

The MAI of kauri appears to be slow at first, but takes off later. Using provisional models to evaluate a plantation of this species, Greg Steward came up with a startling figure of 7-11% for the IRR! This greatly exceeds radiata pine. This author would need some convincing before endorsing that number.

There was some discussion about kauri die-back (*Phytopthora* taxon *Agathis*). Is the disease a fungus, a virus or the same thing that kills cabbage trees? Is it native, exotic or a hybrid? Obviously we need more work on this.

Excellent wood properties in plantation grown kauri

Summary

The Diversified Forests Programme has proved more successful than even an optimist would have dared hope. It has enabled us to choose species from the bewildering number of contenders, to pick the best seedlots from those species, and given us a guide as to how to manage those. The entire New Zealand forest sector needs this Programme; without it, even the most hard-nosed radiata forester would discover that they would soon lose the support of the public or the authorities.

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